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REVIEW

Osteo-odonto-keratoprosthesis: a surgical procedure for treating advanced corneal diseases

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Abstract

Corneal blindness remains a significant challenge in modern ophthalmology, accounting for 12% of global blindness cases. While corneal transplantation is often an effective treatment, its success is limited in patients with severe ocular surface diseases such as Stevens-Johnson syndrome, trachoma, or autoimmune-related dry eye disease. For these patients, osteo-odonto-keratoprosthesis (OOKP) has emerged as a highly specialized surgical solution, utilizing a patient's tooth as a scaffold for an artificial cornea, providing long-term visual restoration. This article traces the historical evolution of keratoprostheses, beginning with early 19th-century attempts at artificial cornea implantation to the modern Rome-Vienna protocol of OOKP. The surgical procedure is outlined from both ophthalmological and surgical perspectives, detailing key modifications, such as complete removal of the iris and lens, use of custom-made optical cylinders, and advanced biocompatible materials. These improvements have significantly enhanced the stability and longevity of the procedure while reducing the risk of complications such as glaucoma, inflammation, and implant rejection. A systematic review of scientific literature was conducted, analyzing 39 sources primarily obtained from PubMed. Researchers carefully selected these articles based on their abstracts to ensure relevance, providing a comprehensive analysis of OOKP.This article highlights its role as an advanced alternative for treating end-stage corneal blindness, offering hope to patients who are not candidates for conventional corneal transplantation. Osteo-odonto-keratoprosthesis (OOKP) is an innovative method for restoring vision in patients with severe corneal damage, significantly improving their quality of life. While the procedure presents challenges and risks, many individuals who undergo OOKP regain the ability to see and regain independence. Technological advancements should focus on refining the technique, minimizing complications, and increasing its accessibility. Additionally, patient education and support are crucial for successful rehabilitation and adaptation. OOKP is a remarkable achievement in medicine and biomedical engineering, offering hope to patients and inspiring further research to enhance the quality of life for people worldwide.

Keywords Osteoodontokeratoprothesis (OOKP) · Corneal blindness · Dental surgery · Ophthalmology · Surgical treatment

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1 Introduction

According to the World Health Organization, 4,9 million people are blind due to corneal pathologies, accounting for 12% of all blindness cases worldwide (Pascolini and Mariotti 2012). In most cases, corneal transplantation is an effective therapeutic measure for restoring vision to individuals affected by blindness. However, its effectiveness diminishes in the presence of various diseases such as trachoma, superficial corneal ulcers, keratoconjunctivitis, rosacea (Nema and Nema 2008), and Stevens-Johnson syndrome, which lead to corneal neovascularization, dry ocular surface, and recurrent inflammation or infections (Avadhanam et al. 2015). Osteo-odonto-keratoprosthesis (OOKP) is one of the most advanced and effective surgical solutions for patients suffering from severe corneal diseases. This operation aims to use a tooth as a substitute for the cornea. This method has been refined over the years and is now known as the Rome-Vienna protocol. Thanks to its unique design and complex surgical procedure, OOKP offers patients a chance to significantly improve their visual field quality and provides stable therapeutic outcomes. This article delves deeper into osteo-odonto-keratoprosthesis, examining its historical background, development, patient qualification criteria, and potential complications that both doctors and patients might encounter. In the context of rapid technological and surgical advancements, understanding OOKP is crucial for both ophthalmology specialists and dental surgeons. This article aims to provide readers with a comprehensive overview of OOKP, highlighting its role and potential in treating ocular diseases globally while showcasing a method that offers hope for improving the quality of life for patients with advanced corneal disorders.

2 Historical background

The first mentions of treating corneal diseases date back to 1789 when French surgeon Pellier de Quengsy proposed the creation of an artificial cornea as a treatment for corneal opacification (Chirila and Hicks 1999). In 1855, Dr. Nussbaum introduced a two-part keratoprosthesis resembling a rivet, made of quartz crystal. The prosthesis consisted of two segments encasing the cornea from both the anterior and posterior sides, connected by a cylindrical element serving as the optical component (Zagórski 2008). Implantation of the keratoprosthesis was associated with significant complications, and most procedures failed due to implant loss. Groundbreaking research on keratoprostheses was conducted in the 1950 s, leading to the emergence of many new alternatives. All of them featured an optical component in the shape of a cylinder and a supporting structure (the haptic part) that secured the prosthesis to the patient's tissue (Zagórski 2008). The design of the supporting structure is crucial, as it significantly impacts the durability of the prosthesis-tissue integration. The ideal keratoprosthesis should surpass the natural cornea in terms of optical quality and power, minimize aberrations, ensure excellent biointegration, resist infections, and provide a long-term solution. Another essential feature is the ability to facilitate drug delivery and measure intraocular pressure (Shetty et al. 2014). The supporting structure must contain openings that allow nutrients to reach the outer corneal layers while preventing the leakage of aqueous humor. One of the key challenges in keratoprosthesis research has been the degradation of tissues surrounding the prosthesis, caused by necrosis or disruptions in the nourishment and vascularization of ocular structures. These issues were often induced by mechanical pressure or tissue reactions to the presence of a foreign body. The consequences of these processes included leakage, prosthesis migration, and, in severe cases, the development of endophthalmitis (Zagórski 2008).

There are three main strategies to stabilize keratoprostheses and improve their functional outcomes. The first involves strengthening the corneal scar surrounding the prosthesis scaffold by using additional tissues such as donor cornea, sclera, periosteum, fascia lata, or oral mucosa. The second method focuses on varying the depth of scaffold placement relative to the cornea, which can be achieved through fixation in epikeratoprosthetic, intrakeratoprosthetic, or retrokeratoprosthetic layers (Zagórski 2008). The third approach utilizes materials that minimize tissue damage while promoting better integration of the keratoprosthesis with the host tissues (Tan et al. 2015). The pioneer of keratoprostheses using bone, cartilage, or teeth was Italian ophthalmic surgeon Benedetto Strampelli. In 1963, his research led to the development of a bone-dentine corneal prosthesis. This method was further refined by Falcinelli in 1998 through the introduction of specific modifications (Falcinelli et al. 2005). These advancements resulted in what is now known as the modified osteo-odonto-keratoprosthesis (MOOKP) (Holland et al. 2021).

The modifications included:

- Complete removal of the iris via total iridodialysis,
- Total removal of the lens and anterior vitreous body, as failure to perform these procedures led to secondary glaucoma caused by angle closure and severe inflammation of membranes behind the optical cylinder (Hille et al. 2005).

- Use of oral mucosa from the alveolar ridge or cheek; if unavailable, mucosa from the palate, lip, or vagina could be used,
- Custom-made optical cylinder design,
- Increased diameter of the optical cylinder,
- Removal of Bowman's membrane,
- Use of fibrin glue to attach the periosteum (Zagórski 2008); Hille et al. 2005).

These modifications provided improved aesthetic outcomes and enhanced prosthesis stability. The MOOKP technique has since spread globally, with successful applications in countries such as Austria, Germany, Japan, Singapore, and India.

In the OOKP technique, the cylinders are made of polymethyl methacrylate (PMMA) and e.g. teflon which is used in the Cardona keratoprosthesis. Dentin, being a hard tissue with a low metabolism, serves as a stabilizer for the cylinder, enabling the restoration of vision in patients with severe surface eye damage (Falcinelli et al. 2005; Ang et al. n.d.). It can thus be argued that attaching the acrylic cylinder to a previously obtained bone fragment along with the patient's tooth and placing it in a "pocket" created from cornea tissue prevents the rejection of the prosthesis by the host's body. The optical cylinder, due to its durable and tight connection with PMMA using acrylic resin, effectively prevents the formation of a fistula (Falcinelli et al. 2005).

Numerous attempts have been made to develop synthetic keratoprosthesis., One such example is the Boston Keratoprosthesis (Boston KPro), which is the most widely implanted keratoprosthesis globally and was developed by C. Dohlman. The Boston KPro consists of an optical cylinder made of polymethyl methacrylate (PMMA), while the posterior plate is titanium. Additionally, the design includes a titanium locking ring that secures the posterior plate (Nonpassopon et al. 2020).However, this type of prosthesis does not eliminate the need for a donor cornea, which serves as a carrier and is positioned between the anterior and posterior plates (Holland et al. 2021). Furthermore, to support the optical cylinder, various materials are used (Shetty et al. 2014), such as Dacron (Pintucci keratoprosthesis) (Chammartin et al. 2009), alumina ceramic (Polack keratoprosthesis) (Pintucci et al. 1995), polytetrafluoroethylene (Legeais keratoprosthesis) (Hollick et al. 2006), Teflon (Avadhanam et al. 2015) and silicone resins. The use of these materials was associated with a significantly higher rate of prosthesis rejection compared to OOKP, ranging from 21% (Cardona) to 10% (Pintucci) (Shetty et al. 2014). Additionally, hydrogel keratoprostheses (Alphacor) were implanted, achieving a 62% retention rate after 2 years (Hicks et al. 2006). Its greatest advantage is the ability to create a one-piece, flexible structure in which both the optical component and the scaffold are made from the same material, eliminating issues related to component integration (Zagórski 2008) (Fig. 1).

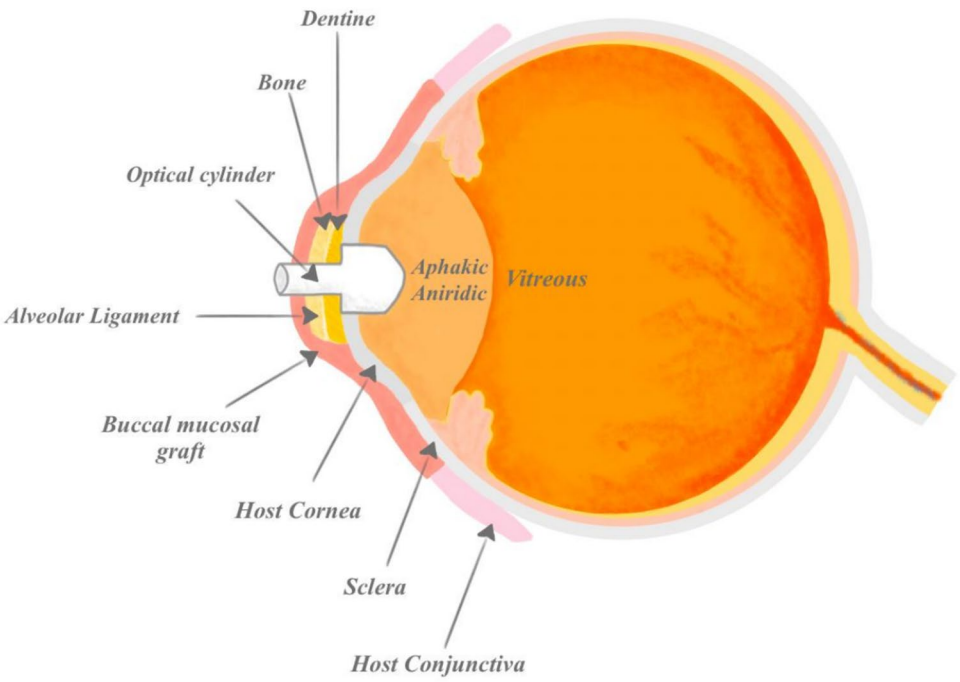

Fig. 1 Diagram of the osteo-odonto-keratoprosthesis (OOKP)

3 Qualification for the procedure

The primary indications for the procedure include adult patients with bilateral corneal blindness, end-stage ocular surface disease (OSD), severe limbal stem cell deficiency, Lyell's syndrome, and eyelid loss resulting from conditions such as Crouzon syndrome (Hille et al. 2005; Ortiz-Morales et al. 2022). However, the procedure is most commonly performed in cases of chemical, physical, and thermal injuries, toxic epidermal necrolysis (TEN), end-stage autoimmune dry eye, ocular scarring, and Stevens-Johnson syndrome (SJS) (Ortiz-Morales et al. 2022; Iyer et al. 2010; Cornea n.d.).

Some indications for keratoprosthesis implantation and ocular surface reconstruction using limbal stem cell transplantation overlap; therefore, the advantages and disadvantages of both techniques must be carefully considered (Hille et al. 2005). Corneal surface reconstruction using limbal stem cell transplantation appears to be less destructive to the anterior segment of the eye. If the procedure is successful, patients may achieve a wide visual field. However, its disadvantages include the necessity of lifelong systemic immunosuppression and the risk of graft rejection in the short term (Solomon et al. 2002).

The central visual acuity is often lower in patients undergoing limbal stem cell transplantation compared to those receiving osteo-odonto-keratoprosthesis (OOKP) due to persistent or recurrent corneal surface issues. Extensive experience from physicians at the "Modified OOKP Centre" in Rome indicates that visual acuity tends to be poorer in cases where multiple anterior segment surgeries were performed before OOKP (Hille et al. 2005).

For a patient to qualify for OOKP implantation, an ophthalmological examination must rule out conditions such as advanced glaucoma, irreversible retinal detachment, and tuberculosis (Zagórski 2008; Tan et al. 2012). There are also absolute contraindications, including age below 17 years and eyes completely lacking light perception, as well as relative contraindications such as defective light perception or patients with psychiatric disorders (Hille et al. 2005; Tan et al. 2012).

It is also crucial to assess the potential visual acuity by evaluating the functional integrity of the retina and optic nerve. Examination of the external ocular structures includes assessing the eyelids, fornices, and determining the degree of tear deficiency (Zagórski 2008).

The evaluation of a patient's eligibility for surgery must also include a dental examination. This involves assessing the condition of the oral mucosa of the cheeks and lips, as well as overall oral hygiene. A critical aspect of this process is verifying the presence of a healthy single-rooted tooth. Orthopantomography (OPG) can be helpful in selecting the most suitable tooth. Additionally, a dental radiograph allows for an assessment of the root in terms of length, circumference, presence of caries, pulp condition, periodontal diseases, jawbone integrity, and its proximity to adjacent teeth.

Teeth that have undergone prior treatment may pose challenges due to persistent bacteria within dentinal tubules. The removal of a filling can lead to reinfection of the root, posing a risk to the integrity of the prosthesis. While dental crown pathologies may not necessarily be exclusionary, any signs of periodontal disease are significant. The decisive factors in tooth selection include its size and shape, the quality of surrounding tissues and bone, as well as the potential cosmetic defect resulting from the procedure (Zagórski 2008).

Currently, the best and most commonly used diagnostic method is spiral computed tomography.

The preoperative psychological evaluation before OOKP surgery is crucial. This assessment aims to consider several key aspects. First and foremost, it is important to evaluate how long-term visual impairment may have affected the patient's psychological state. Additionally, discussing the patient's expectations regarding vision improvement and potential aesthetic outcomes is essential to ensure they have a realistic understanding of the final result. Financial, temporal, and emotional stress factors associated with the treatment process must also be considered. Another critical step involves an open discussion about the risks of potential complications, both during and after the procedure. Lastly, it is vital for the patient to acknowledge that lifelong follow-up visits will be necessary to ensure proper care and continuous monitoring of their health status(Kaur 2018).

4 Dental surgery

The surgical technique for osteo-odonto-keratoprosthesis (OOKP) consists of three phases performed under general anesthesia in a two-stage procedure, with an interval of 2–4 months between stages (Shetty et al. 2014).

The first stage involves a tooth osteotomy, preparation of the bone-dentine lamina, cementation of the optical cylinder into the lamina structure, and submuscular implantation on the contralateral side in the infraorbital region.

In the initial phase, a healthy, single-rooted permanent tooth—preferably a canine—is subjected to osteotomy from the maxilla or mandible along with the periosteum. The preparation process includes sagittal sectioning of the root and the surrounding jawbone, followed by its removal through the division of the bony bridge. While the crown is held with extraction forceps, the tooth and bone are trimmed from the mesial or distal side using a diamond-coated drill to expose the pulp, which is entirely and centrally removed (Falcinelli et al. 2005). The choice of the starting side for the resection should consider the region of the bone block where the bone volume is lower. It is

essential to open the pulp canal and completely remove all tissues to ensure a precise fit for the optical cylinder (Hille et al. 2005) (Fig. 2).

In most analyzed studies, canines were used at this stage. However, in cases where a suitable single-rooted tooth of appropriate diameter was unavailable or due to poor dental condition, various substitutes were employed. Falcinelli et al. extracted two smaller teeth along with their roots and bonded them together using acrylic resin (Falcinelli et al. 2005). In cases of edentulism, Falcinelli et al. and Liu et al. (Liu et al. 2008) implemented an allogeneic OOKP transplantation procedure, obtaining teeth from an HLA (Human Leukocyte Antigen)-matched relative. Additionally, De La Paz et al. used autologous tibial bone as an alternative to the alveolar bone (Hille et al. 2006; De La Paz et al. 2011).

A perfectly circular hole is drilled into the dentine to accommodate the anterior part of the PMMA optical cylinder (Falcinelli et al. 2005). The hole must be centered on the dentine, ensuring at least 1 mm of dentine remains on either side of the cylinder. Additionally, as the dentine narrows towards the apex, it is advisable to decenter the hole towards the tooth crown while maintaining the necessary distance between the hole and the lower edge of the crown. This ensures that the posterior enlarged portion of the optical cylinder remains surrounded by alveolar bone (Hille et al. 2005). The crown is removed before drying with filtered oxygen and cementing the optical cylinder. The drill is continuously irrigated with a balanced saline solution to provide cooling. Any detached periosteum is reattached using fibrin glue. The completed keratoprosthesis consists of a sagittally sectioned half of a canine root with its bone, ideally measuring 12 mm × 6 mm × 3 mm, with the optical cylinder surrounded by at least 1 mm of dentine. The ideal bone-dentine lamina should have the same dimensions of 12 mm × 6 mm × 3 mm (Tan et al. 2012). If the surgeon determines that the lamina surface is insufficient for proper optical cylinder insertion, two teeth may be extracted to create two laminae, which are then bonded together using acrylic resin to increase the available surface area. The prepared hole typically has a diameter of 3.70 mm (range: 3.3–4.0 mm), leaving a dentine margin of 1–1.5 mm (Falcinelli et al. 2005) (Fig. 3).

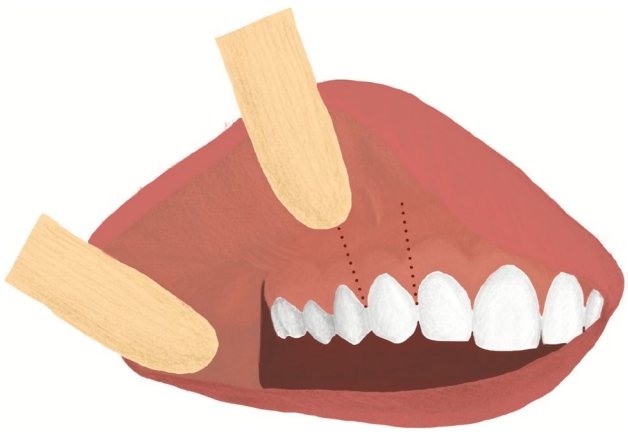

Fig. 2 Anatomical location and course of surgical incisions in the maxilla during preparation for OOKP

The prepared corneal prosthesis is implanted beneath the orbicularis oculi muscle in the cheek, below the eye on the opposite side. After three months, signs of fibrous capsule formation within the buccal mucosal tissue become visible (Shetty et al. 2014) (Fig. 4).

The tissue from the cheek area is then removed to reconstruct the anterior eye wall. The regeneration of both the tissue and the tooth takes approximately two to four months before the next surgical stage. This extended interval is crucial to allow soft tissue infiltration into the porous structure of the bone lamina. Additionally, it enables the lamina to recover from thermal damage, and any infections originating from the oral cavity can be treated while the lamina remains implanted submuscularly rather than being directly placed onto the eye (Ortiz-Morales et al. 2022). Following Stage I, an ophthalmic conformer is often applied to the oral mucosa, and glass rods are inserted daily into the fornices to keep them open (Liu et al. 2005).

The patient receives postoperative instructions on oral hygiene and dietary modifications. Hard foods should be avoided, and antibiotics and pain management medications are prescribed as part of the postoperative care plan (Liu et al. 2005; Odonto-Keratoplasty 2020).

5 Ophthalmology

5.1 Optical cylinder in osteo-odonto-keratoprosthesis: design, functionality, and vision optimization

A crucial component of an osteo-odonto-keratoprosthesis (OOKP) is an appropriate one-piece optical cylinder capable of replacing all optical elements of the eye. Current surgical techniques for OOKP employ single-component cylinders made of polymethyl methacrylate (PMMA), a material that has been in use since the inception of this method and as an intraocular implant. Long-term studies conducted on Italian patients observed over a period of 20–30 years have not demonstrated significant signs of wear or surface scratches. An ideal optical cylinder would need to match the performance of the natural ocular structures it replaces. This represents a highly demanding requirement, as it would necessitate achieving a horizontal visual field of approximately 160° and a visual acuity of 6/5 (Liu et al. 2005). A classic optical cylinder should

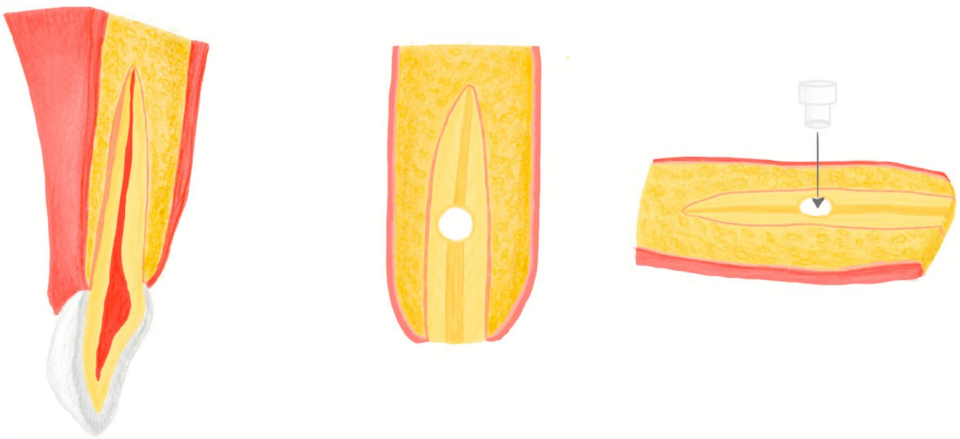

Fig. 3 Components of the osteo-odonto preparation in OOKP: tooth cross-section, dento-osseous lamina, and the site of cylinder placement

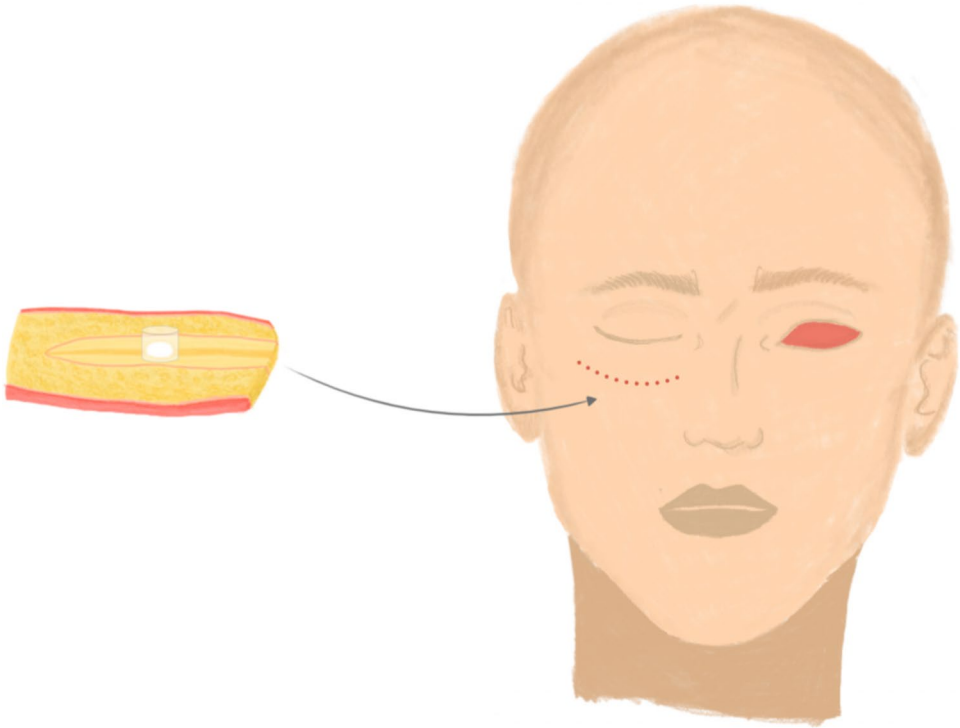

Fig. 4 Schematic illustration of the implantation site for the OOKP

have a dioptric power of approximately 50 to 60 diopters in an aphakic eye (Merlin et al. 1990). To maintain the cylinder in a stable position during the cementation process, the posterior diameter should be slightly larger than the anterior diameter. Ensuring that the posterior cylinder rests solely on the dentin is crucial to preventing contact between the acrylic cement and the bone, as such contact could compromise the stability of the alveolar ligament. Excessive enlargement of the posterior cylinder diameter should be avoided, as it may lead to an undesired expansion of the visual field. Additionally, it is essential to prevent excessive corneal opening during the subsequent surgical stage to avoid potential tilting of the optical cylinder, vascularization of the anterior chamber, formation of a retroprosthetic membrane, and other challenging complications (Hille et al. 2005).

The optical cylinders used in the original Italian OOKP method provided a very limited visual field of approximately 40° (Liu and Pagliarini 1999). This relatively narrow field of vision results from the necessity of a long and narrow cylinder, creating a viewing experience similar to looking through a tube. The length of the anterior portion of the cylinder is determined by the need to pass through the dentoalveolar bone plate and the mucous membrane, as well as the potential requirement for a fixation point for a cosmetic covering. This dimension should be restricted to

the dentin area of the dentoalveolar plate to ensure proper cylinder positioning. Additionally, a moderate pupil size must be considered to prevent excessive glare (Liu et al. 2005).

Studies conducted in 2000 demonstrated that single-piece optical cylinders with an expanded posterior (intraocular) cylinder theoretically increased the visual field by 18%. In contrast, two-piece designs based on the principle of an inverted telephoto lens achieved theoretical visual field angles exceeding 120°. The findings indicated that incorporating aspheric surfaces improved off-axis image quality while maintaining a potential visual acuity of at least 6/6. This is significant, as it may contribute to an increased measured visual field by enhancing off-axis retinal illumination. These results suggest that the theoretical maximum visual field can be substantially expanded through the use of OOKP optical cylinders. Such designs hold the potential to improve visual rehabilitation outcomes for patients undergoing this procedure (Hull et al. 2000 Dec).

5.2 Surgical procedure in ocular phase

The surgical approach consists of a two-stage procedure, further divided into three distinct steps.

Stage 1a involves the preparation of the osteo-odonto-keratoprosthesis (OOKP) and its submuscular implantation on the contralateral side in the infraorbital region. Stage 1b includes the removal of the outer corneal layers, specifically the corneal epithelium and Bowman's membrane, and their replacement with a full-thickness buccal mucosal graft to cover the ocular surface. This ensures a stable mucosal barrier that surrounds and protects the OOKP plate (Shetty et al. 2014; Tan et al. 2012). The final stage (2) consists of retrieving the keratoprosthesis complex prepared in Stage 1a, elevating the mucosal graft placed in Stage 1b, and inserting and stabilizing the prepared corneal prosthesis. During Stage 1b, a full-thickness, muscle-free buccal mucosal graft, typically 3 cm in diameter, is harvested. The preferred donor site is the mucosa overlying the broad fascia or donor sclera, as it contains stem cells, exhibits high proliferative capacity, and is adapted to a high bacterial load (Liu et al. 2005). The harvesting procedure requires precision to avoid injury to the opening of the parotid duct, trauma to the inferior buccal groove, and accidental damage to the mental nerve (Tay et al. 2007). Differences in surgical techniques at this stage relate to the area from which the oral mucosal graft is harvested. Studies by Tan et al. (2012; Falcinelli et al. 2005), and Fukuda et al. (2008) utilized the buccal mucosa from the inner cheek, whereas De La Paz et al. 2011) and Marchi et al. (1994) selected mucosa from the inner surface of the upper or lower lip, which is thinner (Tan et al. 2012).

Next, the anterior ocular surface is prepared for transplantation by performing a 360° peritomy, separating the conjunctiva and Tenon's capsule from the sclera. Synechiolysis is carried out to break adhesions between the cornea and lens, followed by the complete removal of the corneal epithelium and Bowman's membrane. If the cornea is extremely thin, lamellar keratoplasty is performed instead (Shetty et al. 2014). The mucosal graft is sutured to the rectus muscle insertions on the sclera as well as to the conjunctival edges in all four quadrants, using interrupted 6–0 Vicryl sutures (Liu et al. 2005). Before Stage 2, the transplanted mucosa undergoes vascularization, ensuring adequate blood supply to the osteo-dental lamina while also protecting the anterior surface of the OOKP from mechanical trauma and infections. It is advantageous to perform the mucosal graft transplantation in advance, allowing for proper healing before proceeding with tooth extraction and lamina fabrication. This approach can prevent complications related to delayed healing of the buccal mucosa on the ocular surface due to local adverse conditions, poor graft quality, or the need for re-transplantation. If the mucosal graft fails to heal properly, the OOKP plate may undergo resorption due to prolonged retention in the eyelid, increasing the risk of complications. Separating the first stage of the procedure may be necessary in cases of severe anterior segment pathology, which requires additional reparative procedures (Ortiz-Morales et al. 2022).

In most of the studies reviewed, the ocular surface was prepared by performing a superficial keratectomy followed by coverage with oral mucosal grafts. However, Fukuda et al., Hille et al. (Hille et al. 2006), and Iyer et al. (Iyer et al. 2010) did not mention the use of superficial keratectomy in their surgical techniques. Iyer et al. performed lens extraction, complete iridodialysis, and anterior vitrectomy, with or without penetrating keratoplasty, during Stage 1b, whereas in other studies, these procedures were conducted during Stage 2. Iyer et al. also introduced a one-month delay after the initial procedure of covering the ocular surface with a buccal mucosal graft, effectively extending the procedure from two to three stages (Iyer et al. 2010; Tan et al. 2012).

The final stage (2) of the surgery is performed two to four months after the implantation of the keratoprosthesis under the orbicularis oculi muscle (Tan et al. 2012). During this stage, the corneal prosthesis is retrieved, the fibrous capsule is examined, and it is separated from the anterior and posterior surfaces of the PMMA optical cylinder. Traction sutures are placed on the eyelids to facilitate access to the eye. A supporting suture is placed on the superior rectus muscle, and a buccal mucosal flap is formed using an arc-shaped incision under continuous irrigation with balanced salt solution (BSS) and adrenaline (Liu et al. 2005). The procedure involves elevating the mucosal graft to expose the cornea, followed by the suturing of a Flieringa ring, with long sutures left in place for maintaining traction. To reduce intraocular pressure before trephination, intravenous mannitol is administered (Liu et al. 2005). A 5 mm corneal trephination is

then performed, creating a central opening in the eye. The iris, lens, and anterior vitreous body are removed if this was not done in the previous stage (Shetty et al. 2014). This step is essential to prevent postoperative secondary glaucoma or severe intraocular inflammation (Fu and Hollick 2023). A posterior capsulotomy and anterior vitrectomy are performed using a vitrector, ensuring adequate tension through the two Flieringa ring sutures (Liu et al. 2005). The keratoprosthesis is implanted into the corneal opening, with the osteodental lamina serving as a biological protective structure, securing the prosthesis in place. To restore globe integrity, sterile air is injected, followed by fundoscopy to confirm proper centration of the keratoprosthesis implant. Special attention is given to examining the posterior pole of the eye and detecting any vitreous hemorrhage (Liu et al. 2005). The mucosal graft is sutured back to its original attachment site, covering the implant. A 3 mm central trephination of the mucosal graft is then performed, allowing the anterior portion of the optical cylinder to protrude. This step clears the visual axis, enabling light transmission to the retina, ultimately contributing to restored vision clarity (Shetty et al. 2014) (Tables 1).

6 Postoperative care

After each stage of dental surgery, postoperative recommendations include the use of an antiseptic mouth rinse (chlorhexidine 0.2% or triclosan 0.03%) for one month, along with broad-spectrum systemic antibiotics (Basu et al. 2013).

Following the ophthalmic stage, postoperative care involves the administration of prednisolone and oral medications to regulate intraocular pressure, such as acetazolamide, mannitol, and methazolamide. Topical antibiotics such as ciprofloxacin 0.3% or chloramphenicol 0.5% (in ointment form) are also prescribed (Ortiz-Morales et al. 2022). The patient must attend weekly follow-up visits for the first month, monthly visits for the next three months, and bi-monthly check-ups for six months to monitor prosthesis stability, intraocular pressure, refraction, and spectacle correction. Once stability is achieved, follow-ups can be scheduled at longer intervals (Ortiz-Morales et al. 2022; Rishi et al. 2018). Patients must be aware that lifelong monitoring is necessary to ensure early detection of complications. Referral to a prosthodontist is also recommended for oral tissue reconstruction, restoration of chewing function and comfort, and facial aesthetics.

6.1 Complications

Additionally, patients with Stevens-Johnson syndrome are at an increased risk of laminar resorption (Fu and Hollick 2023; Iyer et al. 2014). The data have been presented in Table 2.

6.1.1 Clinical Summary

This data have been presentented in Table 3.

7 Conclusion

Osteo-odonto-keratoprosthesis (OOKP) is an advanced and innovative method for restoring vision in patients with severe corneal damage that significantly impairs daily functioning. Although the procedure presents challenges and risks, its potential to greatly enhance patients' quality of life is invaluable. Many individuals who have undergone OOKP have regained their ability to see, allowing them to once again enjoy everyday activities and regain independence.

Table 1 Comparison of MOOKP and Boston KPro

Feature	MOOKP (Modified Osteo-Odonto-Keratoprosthesis)	Boston KPro
Structure & Materials	Biological (dental lamina with dentin, bone, PMMA optical cylinder)	Biocompatible (PMMA, titanium in Type II)
Application	Extreme cases (SJS, chemical burns, autoimmune diseases)	Type I: Maintains a moist ocular environment; Type II: Designed for dry ocular surfaces
Surgical Procedure	Multi-stage (2–3 stages over months); requires autograft	Single-stage (mainly Type I), simpler and faster
Complications	Lamina resorption (14%), mucosal necrosis, glaucoma (11.5%), retinal detachment (10%)	Glaucoma (66%), retroprosthetic membrane formation (up to 17%), corneal melt (19%) (Wróblewska-Czajka et al. 2024)
Visual Outcomes	78% of patients achieve ≥ 20/400; better long-term stability	Type I: 46.81% achieve ≥ 20/200 within 3 years (Wróblewska-Czajka et al. 2024); Type II: 50–58.6% after 5 years
Availability	14 centers worldwide, requires a multidisciplinary team	More widely available, less infrastructure-dependent
Advantages	Higher tolerance for extreme ocular surface damage	Easier and faster to perform; more accessible
Disadvantages	More complex, higher risk of complications (Ortiz-Morales et al. 2022)	Shorter durability in harsh conditions, higher risk of retroprosthetic membranes

The table summarizes the key differences between MOOKP and Boston KPro, indicating their applications, results, and limitations

Table 2 Most common complications associated with MOOKP

Category	Complications	Notes
Maxillofacial	- Mandibular fracture - Failed tooth extraction - Fistula formation - Exposure of the root of an adjacent tooth - Perforation of the oral mucosal flap - Oral discomfort due to pressure - Maxillary sinus perforation - Submucosal scarring at the implantation site - Rejection of the bone-tooth complex - Paresthesia at the implantation site - Sinusitis - Infection at the graft site (Ortiz-Morales et al. 2022)	Most common intraoperative complication
Mucosal complications	- Graft defect - Mucosal overgrowth - Mucosal necrosis (Basu et al. 2013)	
Glaucoma	- High preoperative intraocular pressure - Predisposition in autoimmune diseases (mucous membrane pemphigoid, Stevens-Johnson syndrome) (Fu and Hollick 2023)	Most common late complication after artificial cornea transplantation
Laminar resorption	-More frequent in patients with Stevens-Johnson syndrome (Fu and Hollick 2023; Iyer et al. 2014)	Risk increases in autoimmune diseases

The table summarizes the most common complications associated with MOOKP, their characteristics, and risk factors

Table 3 This table presents a clinical summary of OOKP use

Clinical Parameter	Value/Outcome	Source
Postoperative Complications	- Prosthetic plate necrosis or rejection: **16.1%** - Secondary glaucoma: **11.5%**	Ortiz-Morales G et al. (2022) The evolution of the modified osteo-odonto-keratoprosthesis, (Ortiz-Morales et al. 2022)
Effectiveness of Visual Restoration	**83%** of patients achieve visual function improvement	Liu et al. (2008), Visual rehabilitation in end-stage inflammatory ocular surface disease. (Liu et al. 2008)
Long-Term Stability	**85%** probability of maintaining an intact OOKP **18 years** postoperatively	Falcinelli et al. (2005), Modified osteo-odonto-keratoprosthesis for corneal blindness. (Falcinelli et al. 2005 Oct)
Prosthesis Loss	**10–20%** prosthesis loss due to complications within **10 years**	De La Paz et al. (2011), Impact of clinical factors on OOKP outcomes. (De La Paz et al. 2011)

It is essential that technological advancements focus on refining this technique, minimizing the risk of complications, and increasing the availability of the procedure to a broader patient population. Furthermore, patient education and support for both individuals and their families are crucial in the rehabilitation process and adaptation to their new reality.

In summary, the application of OOKP represents a remarkable achievement in modern medicine and biomedical engineering, overcoming complex health challenges. It offers hope not only to patients but also serves as an inspiration for the medical community, driving further research and innovations aimed at improving the quality of life for people worldwide.

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Data availability All data supporting the conclusions of this study are obtained from previously published sources, as cited in the References section. The study is entirely based on the analysis and interpretation of existing scientific literature.

Declarations

Ethics statement This study did not involve human participants or animals. Ethical approval was therefore not required.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication The participant has consented to the submission of the case report to the journal.

Competing interests The authors declare no conflict of interest.

References

Ang M, Man R, Fenwick E, Lamoureux E, Wilkins M (2017) Impact of type I Boston keratoprosthesis implantation on vision-related quality of life. Br J Ophthalmol. https://doi.org/10.1136/bjophthalmol-2017-310745

Avadhanam VS, Smith HE, Liu C (2015) Keratoprostheses for corneal blindness: a review of contemporary devices. Clin Ophthalmol 16(9):697–720. https://doi.org/10.2147/OPTH.S27083

Basu S, Pillai VS, Sangwan VS (2013) Mucosal complications of modified osteo-odonto keratoprosthesis in chronic Stevens-Johnson syndrome. Am J Ophthalmol 156(5):867-873.e2. https://doi.org/10.1016/j.ajo.2013.06.012

Chammartin M, Goldblum D, Fruh B, Wilkens L, Bosshardt D, Sarra GM (2009) Case report of osteo-odonto keratoprosthesis (Strampelli) and of dacron keratoprosthesis (Pintucci). Klin Monatsbl Augenheilkd 226:180–183. https://doi.org/10.1055/s-2008-1027997

Chirila TV, Hicks CR (1999) The origins of the artificial cornea: pellier de quengsy and his contribution to the modern concept of keratoprosthesis. Gesnerus 56(1–2):96–106

Cornea and External Eye Disease, Larkin, D.F.P. ; Reinhard, Thomas, Page 39

De La Paz MF, De Toledo JÁ, Charoenrook V et al (2011) Impact of clinical factors on the long-term functional and anatomic outcomes of osteo-odonto-keratoprosthesis and tibial bone keratoprosthesis. Am J Ophthalmol 151(5):829-839.e1. https://doi.org/10.1016/j.ajo.2010.11.011

Falcinelli G, Falsini B, Taloni M, Colliardo P, Falcinelli G (2005) Modified osteo-odonto-keratoprosthesis for treatment of corneal blindness: long-term anatomical and functional outcomes in 181 cases. Arch Ophthalmol 123(10):1319–1329. https://doi.org/10.1001/archopht.123.10.1319

Fu L, Hollick EJ. Artificial Cornea Transplantation. [Updated 2023 Apr 20]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK568692/

Fukuda M, Hamada S, Liu C, Shimomura Y (2008) Osteo-odonto-keratoprosthesis in Japan. Cornea 27(Suppl 1):S56-61. https://doi.org/10.1097/ICO.0b013e31817f1fe4

Hicks CR, Crawford GJ, Dart JK, Grabner G, Holland EJ, Stulting RD, Tan DT, Bulsara M (2006) Alphacor: clinical outcomes. Cornea 25(9):1034–1042. https://doi.org/10.1097/01.ico.0000229982.23334.6b

Hille K, Grabner G, Liu C, Colliardo P, Falcinelli G, Taloni M, Falcinelli G (2005) Standards for modified osteoodontokeratoprosthesis (OOKP) surgery according to Strampelli and Falcinelli: the Rome-Vienna protocol. Cornea 24(8):895–908. https://doi.org/10.1097/01.ico.0000157401.81408.62

Hille K, Hille A, Ruprecht KW (2006) Medium term results in keratoprostheses with biocompatible and biological haptic. Graefes Arch Clin Exp Ophthalmol 244(6):696–704. https://doi.org/10.1007/s00417-005-0092-6

Holland G, Pandit A, Sánchez-Abella L, Haiek A, Loinaz I, Dupin D, Gonzalez M, Larra E, Bidaguren A, Lagali N, Moloney EB, Ritter T (2021) Artificial cornea: past, current, and future directions. Front Med (Lausanne) 12(8):770780. https://doi.org/10.3389/fmed.2021.770780

Hollick EJ, Watson SL, Dart JK, Luthert PJ, Allan BD (2006) Legeais BioKpro III keratoprosthesis implantation: long term results in seven patients. Br J Ophthalmol 90(9):1146–1151. https://doi.org/10.1136/bjo.2006.092510

Hull CC, Liu CS, Sciscio A, Eleftheriadis H (2000) Optical cylinder designs to increase the field of vision in the osteo-odonto-keratoprosthesis. Graefes Arch Clin Exp Ophthalmol 238(12):1002–1008. https://doi.org/10.1007/s004170000191

Iyer G, Pillai VS, Srinivasan B, Falcinelli G, Padmanabhan P, Guruswami S, Falcinelli G (2010) Modified osteo-odonto keratoprosthesis–the Indian experience–results of the first 50 cases. Cornea 29(7):771–776. https://doi.org/10.1097/ICO.0b013e3181ca31fc

Iyer G, Srinivasan B, Agarwal S, Rachapalle SR (2014) Laminar resorption in modified osteo-odonto-keratoprosthesis procedure: a cause for concern. Am J Ophthalmol 158(2):263-269.e2. https://doi.org/10.1016/j.ajo.2014.03.004

Kaur J (2018) Osteo-odonto keratoprosthesis: innovative dental and ophthalmic blending. J Indian Prosthodont Soc 18(2):89–95. https://doi.org/10.4103/jips.jips_283_17

Liu C, Pagliarini S (1999) Independent survey of long term results of the Falcinelli osteo-odonto-keratoprosthesis (OOKP). Anales Del Instituto Barraquer (Barc) 28(S):91–93

Liu C, Paul B, Tandon R, Lee E, Fong K, Mavrikakis I, Herold J, Thorp S, Brittain P, Francis I, Ferrett C, Hull C, Lloyd A, Green

D, Franklin V, Tighe B, Fukuda M, Hamada S (2005) The osteo-odonto-keratoprosthesis (OOKP). Semin Ophthalmol 20(2):113–128. https://doi.org/10.1080/08820530590931386

Liu C, Okera S, Tandon R, Herold J, Hull C, Thorp S (2008) Visual rehabilitation in end-stage inflammatory ocular surface disease with the osteo-odonto-keratoprosthesis: results from the UK. Br J Ophthalmol 92(9):1211–1217. https://doi.org/10.1136/bjo.2007.130567

Marchi V, Ricci R, Pecorella I, Ciardi A, Di Tondo U (1994) Osteo-odonto-keratoprosthesis. Description of surgical technique with results in 85 patients. Cornea 13(2):125–130

Merlin U, Profazio V, Merlin F et al (1990) Optical calculations in mesokeratoprosthesis. In: Caramazza R, Versura P (eds) Biometerials in Ophthalmology: an Interdisciplinary Approach. Studio E.R. Congressi, Bologna, pp 171–176

Narang Deepak Tityal Jeevan, Mishra Vandana, Mittal Sandeep (2020) Odonto-keratoplasty: a review. Int J Res Health Allied Sci

Nema, HV, Nema Nitin (2008) Textbook of ophthalmology, 5th edn. Jaypee Brothers Medical Publishers (p) LTD, New Delhi, p 174

Nonpassopon M, Niparugs M, Cortina MS (2020) Boston type 1 keratoprosthesis: updated perspectives. Clin Ophthalmol 14:1189–1200. https://doi.org/10.2147/OPTH.S219270

Ortiz-Morales G, Loya-Garcia D, Colorado-Zavala MF et al (2022) The evolution of the modified osteo-odonto-keratoprosthesis, its reliability, and long-term visual rehabilitation prognosis: an analytical review. Ocul Surf 24:129–144. https://doi.org/10.1016/j.jtos.2022.03.005

Pascolini D, Mariotti SP (2012) Global estimates of visual impairment: 2010. Br J Ophthalmol 96(5):614–618. https://doi.org/10.1136/bjophthalmol-2011-300539

Pintucci S, Pintucci F, Cecconi M, Caiazza S (1995) New dacron tissue colonisable keratoprosthesis: clinical experience. Br J Ophthalmol 79(9):825–829. https://doi.org/10.1136/bjo.79.9.825

Rishi P, Rishi E, Agarwal V et al (2018) Vitreoretinal complications and outcomes in 92 eyes undergoing surgery for modified osteo-odonto-keratoprosthesis: a 10-year review. Ophthalmology 125(6):832–841. https://doi.org/10.1016/j.ophtha.2017.12.003

Shetty L, Gupta A, Shah N, Shah U (2014) A new vision through combined osteo-odonto-keratoprosthesis: a review. Med J Dr DY Patil Univ 7(3):272–277. https://doi.org/10.4103/0975-2870.128948

Solomon A, Ellies P, Anderson DF, Touhami A, Grueterich M, Espana EM, Ti SE, Goto E, Feuer WJ, Tseng SC (2002) Long-term outcome of keratolimbal allograft with or without penetrating keratoplasty for total limbal stem cell deficiency. Ophthalmology 109(6):1159–1166. https://doi.org/10.1016/s0161-6420(02)00960-0

Tan A, Tan DT, Tan X-W, Mehta JS (2012) Osteo-odonto keratoprosthesis: systematic review of surgical outcomes and complication rates. Ocul Surf 10(1):15–25. https://doi.org/10.1016/j.jtos.2012.01.003

Tan XW, Thompson B, Konstantopoulos A, Goh TW, Setiawan M, Yam GH, Tan D, Khor KA, Mehta JS (2015) Application of graphene as candidate biomaterial for synthetic keratoprosthesis skirt. Invest Ophthalmol Vis Sci 56(11):6605–6611. https://doi.org/10.1167/iovs.15-17306

Tay AB, Tan DT, Lye KW, Theng J, Parthasarathy A, Por YM (2007) Osteo-odonto-keratoprosthesis surgery: a combined ocular-oral procedure for ocular blindness. Int J Oral Maxillofac Surg 36(9):807–813. https://doi.org/10.1016/j.ijom.2007.04.009

Wróblewska-Czajka E, Dobrowolski D, Wylęgała A, Jurkunas UV, Wylęgała E (2024) Outcomes of Boston keratoprosthesis type I implantation in Poland: a retrospective study on 118 patients. J Clin Med 13(4):975. https://doi.org/10.3390/jcm13040975

Zagórski Z, Naumann G, Watson P (2008) Choroby rogówki, twardówki i powierzchni oka, pp 527, 528